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AN ALGEBRAIC APPROACH TO CONDITIONING IN PROBABILITY WITH APPLICATIONS TO THE COMBINATION OF EVIDENCE PROBLEM

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13. ABSTRACT (Maximum 200 words)

This presentation considers a fundamental problem touching upon four major disciplines: probability theory, boolean algebra and logic, ring theory, and the modeling of natural and formal language in expert systems. Specifically, this lecture treats the problem of annexing a conditional event operator to boolean algebra—as originally proposed by Boole and long neglected in the standard semantically oriented literature—which is compatible with all conditional probability evaluations, and which allows for the development of a full calculus of extended boolean operations and relations.

At present, no standard mathematically sound approach exists to the modeling and evaluation of statements such as $p(((a|b) \vee (c|d)i) \cdot e)$, where a, b, c, d, e are all ordinary propositions (unconditional or commonly conditioned) and the bars indicate "if then", or "· given · ·", implicational statements compatible with conditional probability, i.e., $p((a|b)) = p(a|b)$, ordinary conditional probability, for example. The history of formal attempts at solving this problem remain sparse and unconnected, as well as replete with empirical ideas.

In this lecture a new procedure is presented for dealing with the combination of such implicational statements, derived from a minimum of assumptions. This yields a sound and complete logic—conditional probability logic of propositions—which has connections with Koopman's qualitative conditional probability and possesses the algebraic structure of a semi-boolean algebra. Extensive applications to use in expert systems are also exhibited, showing how this new approach to conditioning can be used in design of knowledge-based systems and the treatment of uncertainty factors.

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